2. Introduction

The salinization and alkalization of soils and waters, which are frequently limiting factors in the exploitation of soils, has always been a pressing problem in many countries, particularly in arid and semi-arid regions, as well as in a number of river deltas, plains with poor outflow, etc. During the history of agriculture the importance of this problem has constantly increased, due to the rapid extension of the salinization and alkalization of soils and waters, which, in many places, has caused a sharp reduction in agricultural production. In arid and semi-arid regions, where irrigation is an indispensable precondition for crop production, soil salinity and alkalinity have particular significance. In these areas both soils and waters contain a considerable amount of electrolytes causing salinity and alkalinity.

Generally, irrigation increases the degree of mineralization of soils, except when a good drainage system exists. This effect and the shortage of irrigation water of good quality lead to the salinization and alkalization of vast territories in the dry belt of our Globe contributing to the formation of deserts, to the salinization of fertile areas and to the destruction of ancient civilizations, etc.

On these grounds, it can be stated that society has been confronted with problems of salinization and alkalization since its very early days. Man has had to face this problem throughout his history, but with the advent of modern science and technology, new ways and means of combating these disastrous processes have become possible.

The study of soil salinization and alkalization has long traditions in soil science. Even before soil science became an independent field of research, in various countries where salt affected soils developed, extensive theoretical and practical studies were devoted to the description, investigation and amelioration of these low fertility soils. It is evident that all these investigations were based on the scientific and technical level of the given period and the different approaches to the research and improvement of salt affected soils developed parallelly with the development of basic and applied sciences.

Towards the end of the 19th century one of the classic figures of Hungarian soil science, K. Murakőzy [1902], wrote in a paper dealing with salt affected soils: "In order to fight against soil salinity and alkalinity, one has to be familiar first of all with the nature of this phenomenon." Based on the achievements of modern science we have become more and more familiar with the origin, nature and mechanism of the processes leading to soil salinity and alkalinity.

It is common knowledge that water-soluble salts, mainly sodium salts, are responsible for the formation of saline and alkali soils, but we are still far from having an exact knowledge of the complex processes affecting these soils. The diverse and many-sided reactions between electrolytes and soil particles lead to the formation of different types and varieties of salt affected soils,

which not only have different properties, but also need different types of methods and means of other nature for their reclamation and improvement.

The demand for a quantitative description of soil forming processes has appeared in many branches of soil science and a great number of papers and books have been devoted recently to this kind of study. However, the exact quantitative description of soil forming processes is very difficult, not only because it is not easy in such a complex system as the soil to carry out the necessary accurate measurements of the selected properties, rates of processes, etc., but it is also difficult to choose the most important parameters to be measured in order to characterize the dominating soil forming processes.

These difficulties are reflected in the contemporary technical literature on the modelling of soil forming processes. A great part of the publications in soil science on modelling processes are devoted to problems of salinization or desalinization, irrigation, drainage or related subjects. This situation is probably explained not only by the great theoretical and practical importance of salinization and alkalization, but also by the nature of these soil forming processes, which are a good subject for modelling. The main causes of salinization and alkalization are the accumulation of a considerable amount of electrolytes in the soil solution and their interactions with the solid phase of the soil. The principles of this phenomenon and its appearance are well-known and have been described in detail. In comparison with many other soil forming processes, in which the processes leading to the formation of certain soil types are more complex than the accumulation of electrolytes in solution and the interaction between those solutions and the soil particles, this approach is a simplified model for study. If the interactions of electrolyte solution and soil material are described in an acceptable manner, the mechanism of the formation of salt affected soils can be described too and the rate of the process may be determined. Based on such studies the prediction of salinization and alkalization processes in soils will also be possible.

Evidently, besides the interaction of electrolytes and solid compounds in soils, several other processes, provoked to some extent by this interaction, also occur during the formation of salt affected soils. For example, the quality and quantity of organic compounds and the distribution of silicon compounds in different soil horizons frequently change considerably during salinization and alkalization, as well as during the reverse processes. However, these and other sub-factors of this process may be neglected, when the aim is to elaborate an approach for modelling soil salinization and alkalization. In our opinion this is one of the main reasons why such a large part of the existing studies on the modelling of soil forming processes are devoted to salt affected soils, irrigation, drainage and related subjects.

The other important reason for the numerous model experiments on soil salinization and alkalization is the practical significance of even the partial description of such processes in irrigation and drainage practice. The planning and construction of expensive irrigation and drainage systems, the shortage of irrigation and leaching water of good quality makes it imperative to economize the exploitation of irrigated soils and irrigation water. Whenever such experiments or models are available they can be usefully adopted for practical purposes in order to diminish the amount of irrigation and drainage water, and/or to make it possible to increase the limit values of mineralization in the quality requirements of irrigation and drainage water.

In spite of the fact that the causes and processes of soil salinization and alkalization have been studied more closely than many other soil forming processes, there are a number of uncertainties and unknown factors even in this field. Therefore, up till now, the existing achievements only partially explain the processes of soil salinization and alkalization and there is a large area for further investigation. This is particularly valid for soil alkalinity, where processes due to the alkaline pH of the media and diverse interactions between the liquid and solid phases of the soil make the modelling quite difficult.

In the following chapters of this book we have tried to elaborate models and to use this method for the description of some selected processes of soil salinization and alkalization.

We are aware that our work cannot fulfil this task in full and the aim of the study is only to give a modest contribution to the great problem of exact description of the formation of saline and alkali soils, which is one of the most important questions to be answered by soil scientists in the forthcoming decades.